REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
NC	Production Release	3-12-79	CM DF
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INSTRUCTION MANUAL

REGULATED POWER SUPPLY

LHR MODEL MM30 670-682344

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		CHECKER		INSTRUCTION MANUAL MODEL MM30	
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NEXT ASS'Y	USED ON	TOLERANCE .XX .XXX ANGLE	DWG SIZE A	DWG NO. 46391	REV. A
APPLICATION		UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES	SCALE		Page 1 of 22 Pages

TABLE OF CONTENTS

Section	Page
Specifications	3-6
Introduction	7
Theory of Operation	7-13
Installation and Operation	14-18
Troubleshooting	19-21
Schematic	22
Supplement (When Applicable)	

SPECIFICATIONS

Input Voltage: 115VAC±10% 47-63Hz.
230VAC±10% 47-63Hz.

Output Voltages: Voltages and load current ratings are given in the following table:

Table 1

Output Voltage	Rated Load Current (Amps)
2	175
5	150
12	62
15	50
18	41
24	31
28	26

NOTE: Total output must not exceed 750 watts.

Line Regulation: 0.4% over entire range.

Load Regulation: 0.4% for no load to full load.

Interaction: 0.1% maximum (static).

Ripple and Noise: 1% P-P or 5mV, whichever is greater.

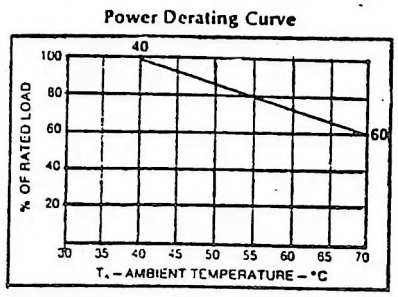
Overvoltage Protection: Factory set at 125±5%.

Overshoots and Undershoots: 2% peak deviation for a 25% load change at 5A/µs.

Response Time: 200µs to 1% after a 25% load change at 5A/µs.

Holdup Time: Output remains in regulation for a minimum of 20MS after loss of nominal AC power.

Operating Temperature: 0°C to 70°C (see derating curve).



Efficiency: Up to 80%, typically 70%.

Output Polarity: The output is independent and floating and may be referenced as desired. The output may be floated up to 100V off chassis ground.

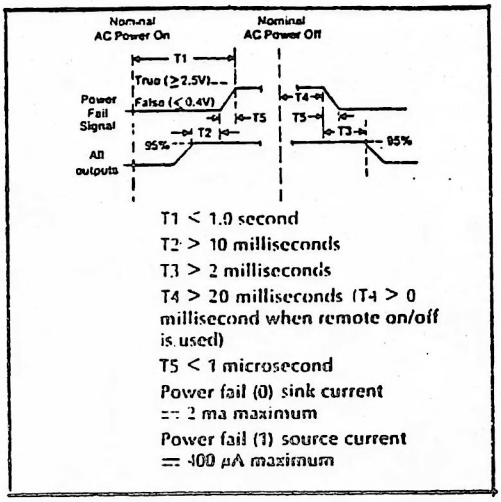
Input Connections: AC input is provided through a heavy duty non-breakable terminal block.

Output Connections: The output with ratings of 750 watts have 5/16 x 18 studs.

Output Adjustments: The output voltage adjustment potentiometer is accessible from the front panel. Current limit and OVP adjustments are factory set.

Power Fail Detection: Upon AC removal, power fail signal will drop to zero at least 2MS before loss of DC output. This signal is referenced to the (-) output stud.

Power On/Off Sequence:



T1 < 1.0 second
T2 > 10 milliseconds
T3 > 2 milliseconds
T4 > 20 milliseconds (T4 > 0 millisecond when remote on/off is used)
T5 < 1 microsecond
Power fail (0) sink current = 2 ma maximum
Power fail (1) source current = 400 μA maximum

Remote On/Off: Power supply is turned on with open circuit or with TTL Logic "1" and is turned off with TTL Logic "0" (800 Mv maximum) sinking 400μA referenced to (1) negative sense terminal.

Current Limit: Foldback current limit with automatic recovery after overload is removed.

Temperature Coefficient: +0.02%/°C.

Storage Temperature: -55°C to +85°C.

Other Features: Remote sense compensates for up to 250mV load cable loss.

Internal thermal switch. Will turn off the power supply in case of overheating.

Input RFI line filter. Independent LC section on each side of the AC line.

Reverse voltage protection. The output has reverse voltage protection up to 100% of rated current.

Other Features: (continued)

Limited inrush current. AC input inrush current is 42 amps RMS when averaged over one cycle.

Automatic internal sensing. Internal sensing is automatic through resistors if sense lines are opened.

Straight paralleling. The output can be straight paralled to provide additional current ratings.

INTRODUCTION

The LHR Switching Power Supply Series MM30, is specifically designed for computer and terminal application. The light weight fan cooled power supply provides one output and is rated for a maximum of 750 watts.

THEORY OF OPERATION

1. General Description (See Figure 1)

The output of the LHR Switching Power Supply is a pulse-width modulated chopper converter.

The AC input is rectified, doubled and filtered to 300VDC in the 115VAC input power Supply. The AC input is rectified and filtered to 300VDC in the 230VAC input power supply. The 300VDC is then chopped and transformed to a lower voltage using a full-bridge-converter.

The transformer secondary output (consisting of a quasi-square wave) is rectified and filtered to the final DC output value.

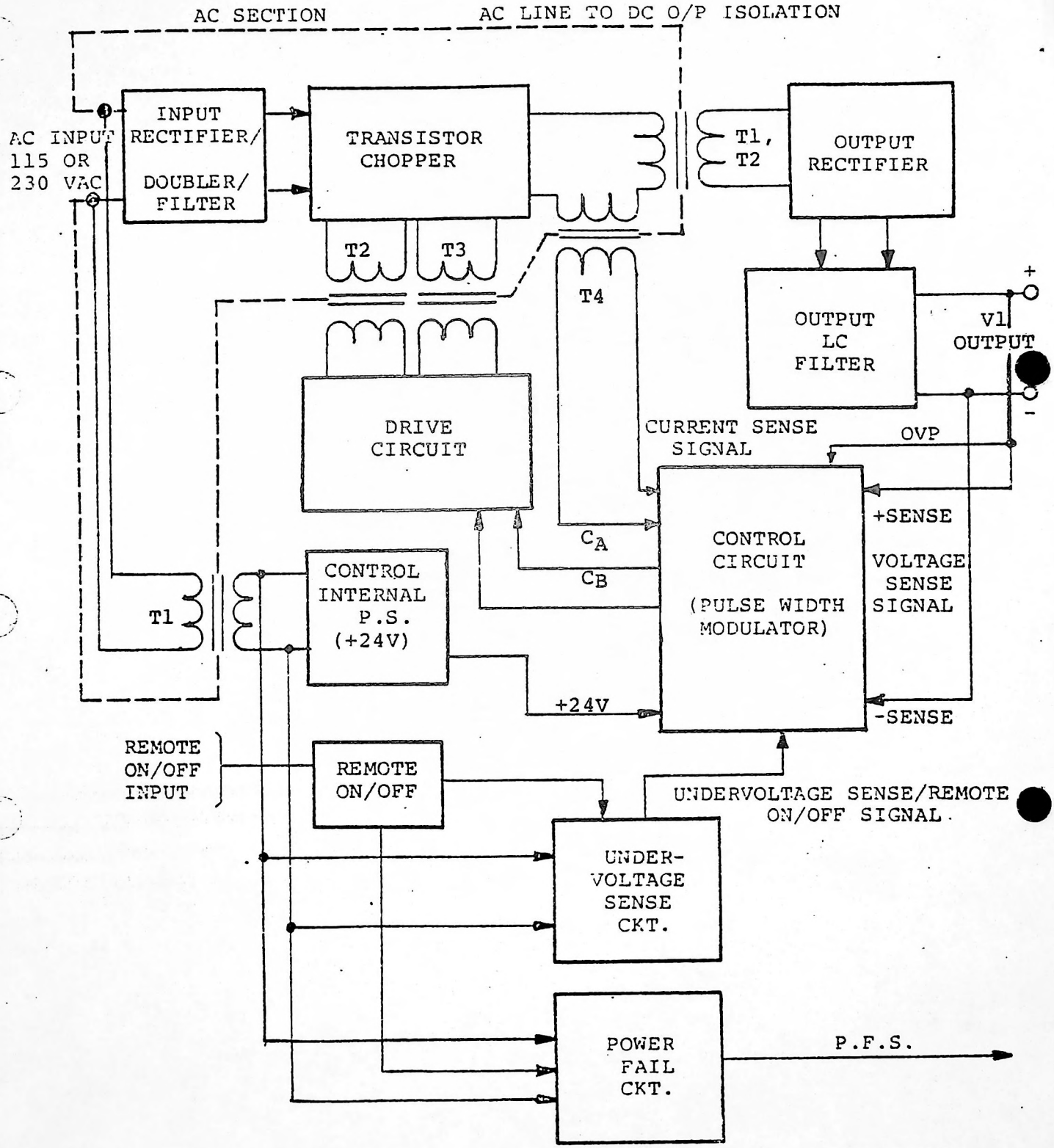
The output is sensed and the error signal voltage is amplified and used to control the pulse width of the chopper, thus regulating the output voltage within narrow limits under all conditions of the input line and the output load.

The output and all control circuitry are isolated from AC input line.

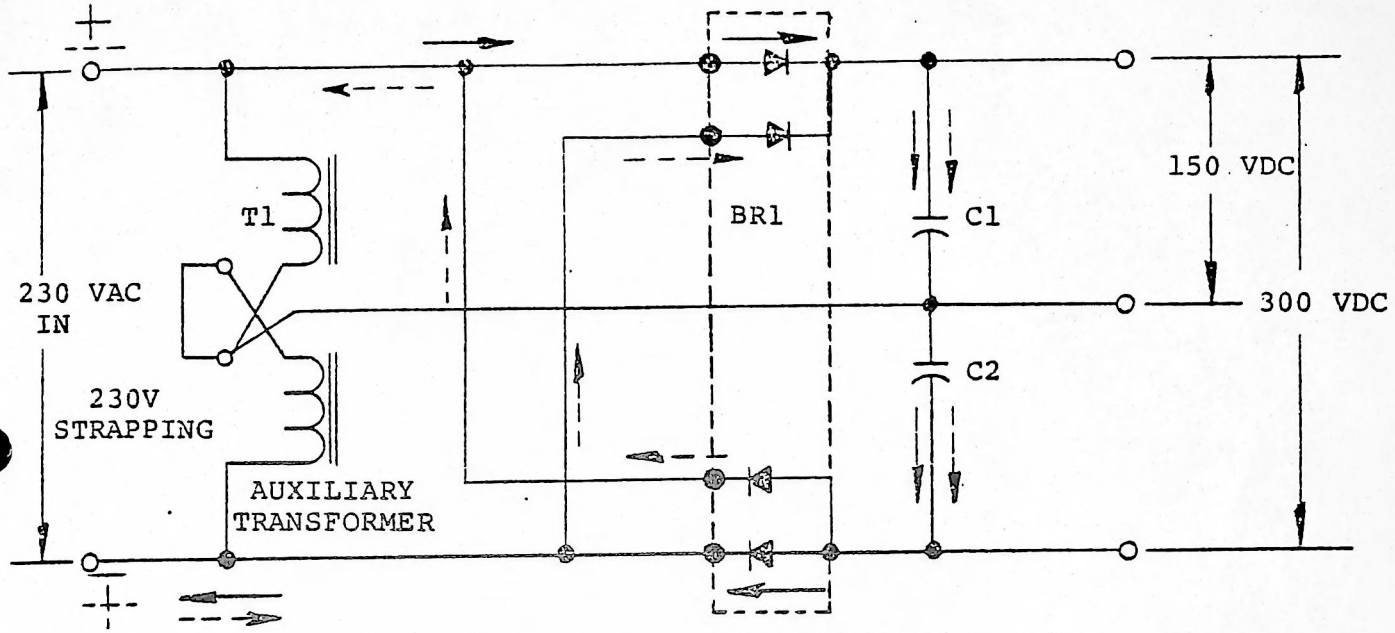
This power supply has input undervoltage sense, soft start control, output current limiting and output overvoltage protection.

2. Detailed Description (See Schematic)

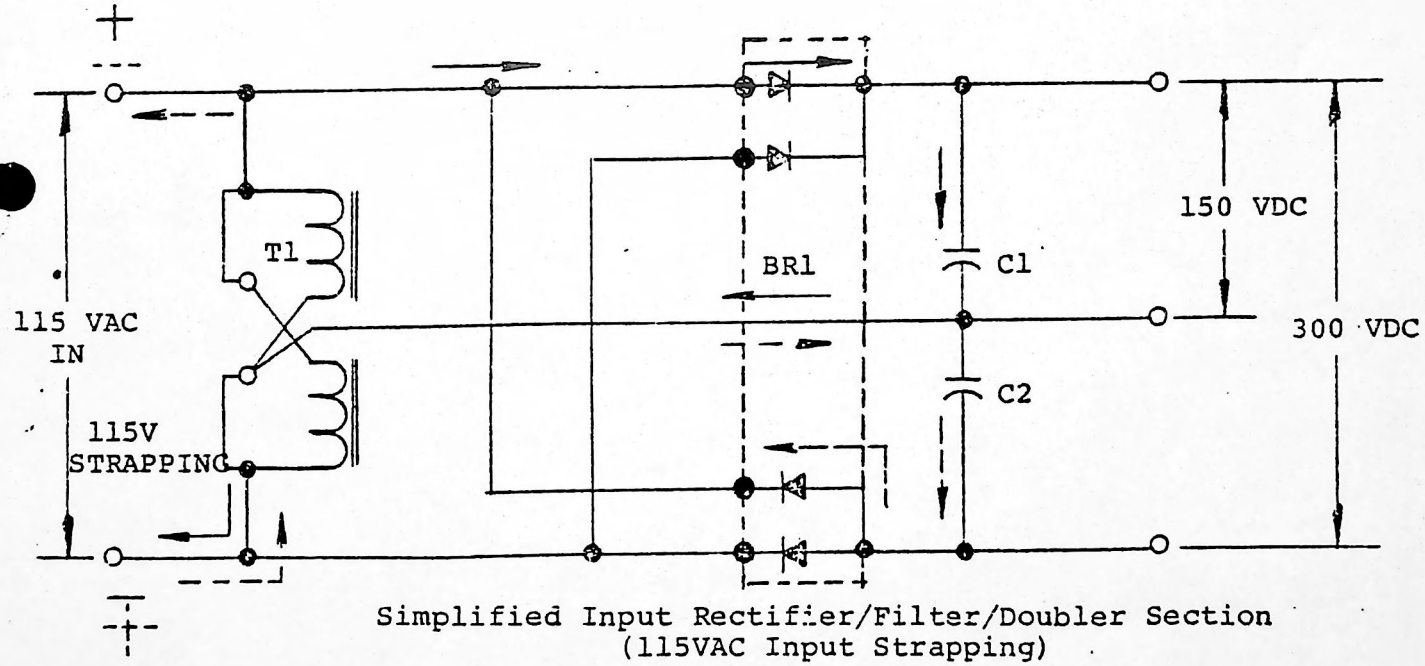
A. Input Filter.
The input filter consists of L1, C1 and C2 that form an RF noise suppression filter. R1 and R4 are thermistors with a high resistance at low temperature. The thermistors limit the input start-up current. The filter operation, including polarity and current flow is described by Figures 2 and 3. R2 and R3 are the bleeder resistors. The strapping connections at T1 allow the use of the same assembly for 115 or 230VAC input.



Block Diagram
Figure 1



Simplified Input Rectifier/Filter Section
(230VAC Input Strapping)
Figure 2



Simplified Input Rectifier/Filter/Doubler Section
(115VAC Input Strapping)

Figure 3

B. Chopper Section. (See Figures 4 and 5)
Transistors Q3, Q6 and Q4, Q5 are alternately turned on and off at a 20KHz rate. C10 is a balance capacitor and T4 is a current sensing transformer. R10 and C6 form a primary RC snubber to attenuate voltage overshoots. CR8, CR9 and CR10, CR11 prevent reverse conduction of Q3, Q6 and Q4, Q5 during transient conditions. The switching action of Q3, Q6 and Q4, Q5 applies a quasi-square voltage waveform of 600 volts peak to peak to primary of T1 and T2.

C. Output Rectifier and Filters.
Quasi-square voltage waveform is transformed down by T1 and T2 on the output board. The output is rectified by CR1, CR2, CR3, and CR4 and filtered by L1 and L2. R1, C1 and R2, C2 form a secondary snubber network. The output is filtered by an LC filter, on the buss bar assembly, consisting of L1, L2 and C1, C2. Ripple and RFI is further reduced by C1, C2, C3, and C4 located on the RFI filter board.

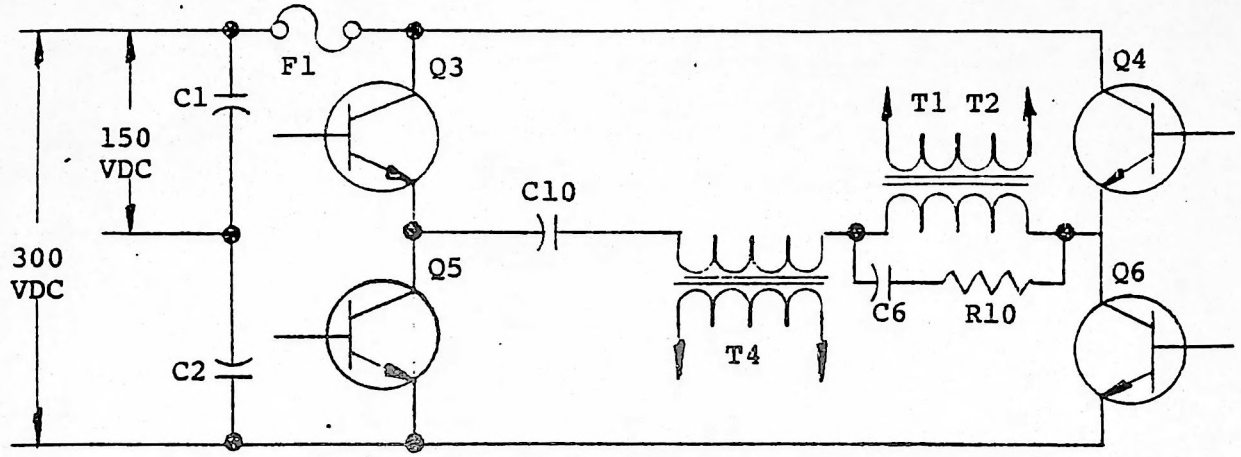
D. Internal Auxiliary Power Supply.
T1 transforms 115 or 230VAC line voltage to supply +24VDC unregulated to the control circuit. CR3, CR4, CR5 and CR6 form a full bridge rectifier and C3 filters the output.

TS1 is a thermal switch in contact with the output rectifier (CR1, CR2, CR3 and CR4) heat sink. TS1 opens if overheating occurs and removes drive to Q3, Q6 and Q4, Q5 by turning off control circuitry.

E. Control Circuitry. (See Table 2)
The control module (45123) contains a pulse-width-modulator, IC SG3524, and provides all the basic control functions as follows:

1) Voltage Amplifier and Reference
2) Overvoltage Protection
3) Undervoltage Protection
4) Soft Start
5) Remote On/Off
6) Power Fail
7) Current Limit

The adjustments on the control module (45123) are factory set, and it should not normally be necessary to readjust the factory settings.



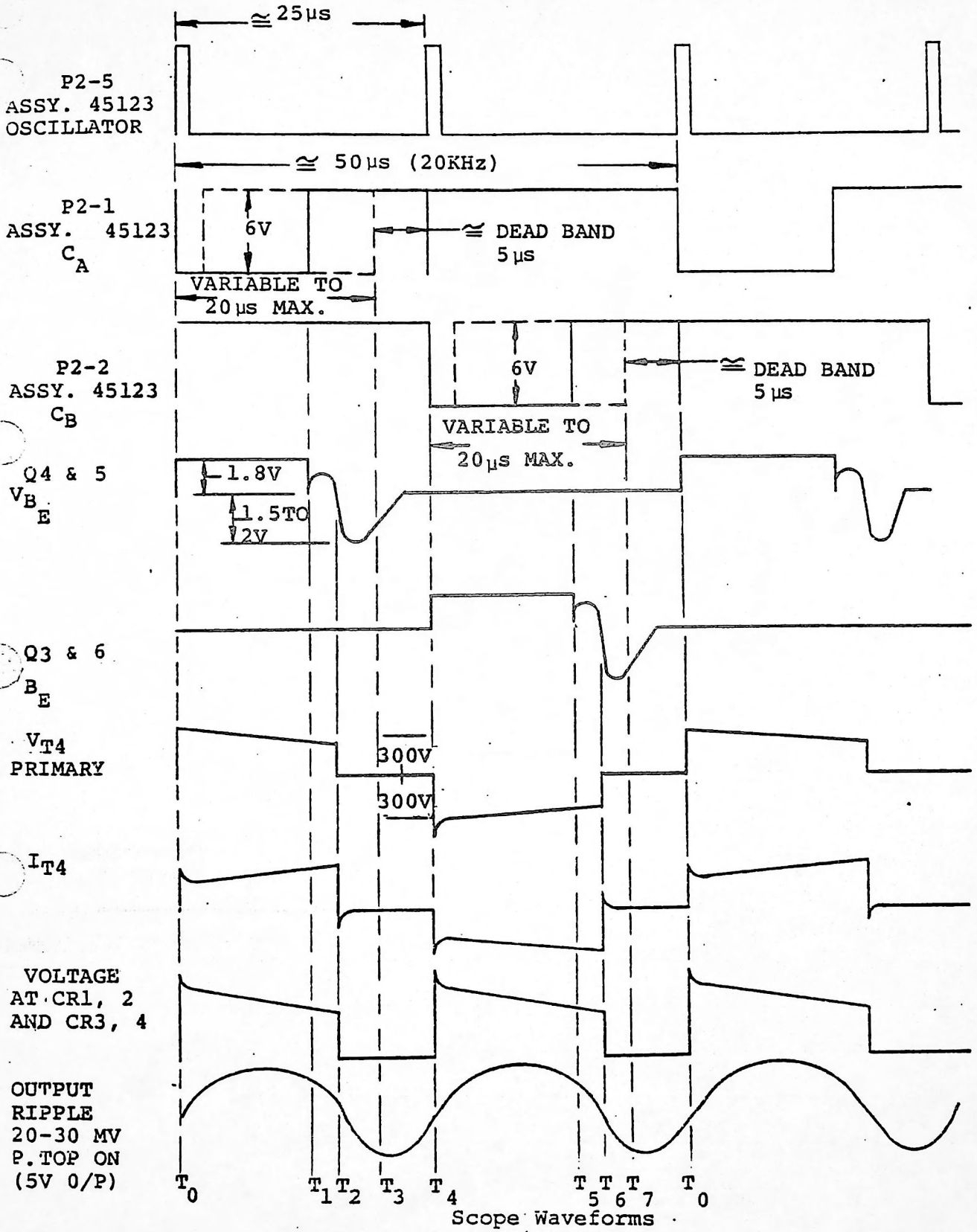
Simplified Transistor Chopper (Full Bridge)
Figure 4

Table 2 below defines the voltage/current levels at nominal line and load conditions, measured on control module.

Table 2

	FUNCTION	MEASUREMENT		FUNCTION	MEASUREMENT
P1-1	OVP	2.3V	P2-1	C_A	See Fig. 5
P1-2	Current Limit	Square Wave, < 1.4 V Peak	P2-2	C_B	See Fig. 5
			P2-3	Power Fail	3.5-5VDC
P1-3	Current Sense	.8-.9VDC	P2-4	-Sense	0
P1-4	Remote On/Off	1.4VDC	P2-5	OSC. Out	See Fig. 5
P1-5	UVS	12-18VDC	P2-6	+Sense Divider	2.2-2.8VDC
P1-6	+24V Input	22-25VDC	P2-7	R_T	----
P1-7	Current Lim Bias	.5-.7VDC	P2-8	Common	0

Note: All measurements are made with respect to pins P2-4 or P2-8.



Scope Waveforms
Figure 5

F. Driver Circuit.
Drive to the bridge transistors Q3, Q4, Q5 and Q6 is provided by two pair of push-pull current source drivers Q1, Q2, Q7 and Q8. Q2 and Q7 base is held at a 5.1V level. Q1 and Q8 are alternately turned on by C_A and C_B. C_A and C_B levels are clamped at 5.7V by CR7 and CR12. Transformers T2 and T3 couple drive signals to the base of Q3, Q4, Q5 and Q6. The snubbers consists of R1, C4 and R7, C7. Resistors, R2 and R8 control the drive current.

INSTALLATION AND OPERATION

1. The power supply is supplied with mounting provisions that use 8-32 screws. Maximum penetration must not exceed 3/8 inch.

   NOTE: This power supply is designed for fan cooling. Do not restrict cooling air flow.

2. Input voltage requirements are 115VAC or 230VAC±10%, 47-63Hz internally selectable. The unit is factory wired for 115V or 230V line as indicated on the name plate. Power supplies with 115-230VAC input voltage may be operated with either voltage. For 115VAC operation, connect jumpers between pads marked 115. See Figure 5A. For 230VAC operation, remove jumpers from pads marked 115 and connect jumper between pads marked 230.

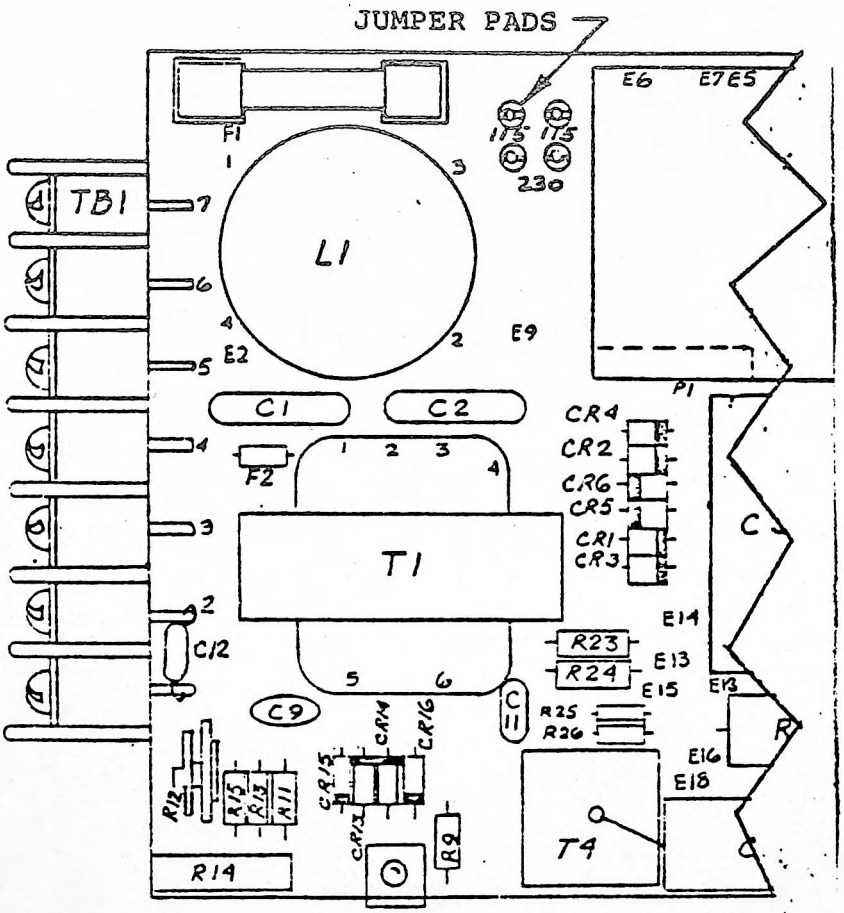


Figure 5A

3. Connect selected input voltage to TB1, AC to terminal 6, AC COMM to terminal 7 and ground to terminal 5.

4. The output voltage with remote sense can compensate for up to 250mV drop in the leads. To determine the minimum size wire, divide 0.25V by the output current, then divide by the total length of wire in thousands of feet. This gives Ohms per 1000 feet, and a wire table may be consulted to determine the appropriate wire size needed. Some examples are included in the following table:

AWG	OHMS PER 1000 FT. @20°C.
6	0.3951
8	0.6282
10	0.9989
12	1.588
14	2.525
16	4.016
18	6.835

Typical Example:

5V @75A supply connected to the load with 4 foot wires, (with 8 ft. total = .008 thousand ft.), #6 wire would be used to insure less than 250mV drop.

5. Connect V1 plus (+) output stud (main output) to (+) point on load.
Connect V1 minus (-) output stud to (-) point on load.

6. Power supplies are shipped with the sense leads connected for local sensing.

NOTE: Step 7 will show how to connect for remote sensing.

7. Connect the +S, TB1-1 terminal 1 (plus sense supply) lead to the (+) point on the main power buss or load.
Connect the -S, TB1-1 Terminal 2 (minus sense supply) lead to the (-) point on the main power buss on load.

NOTE: Sense leads are #22 or #24 twisted pair and must not exceed 10 feet in length.

CAUTION: IF POLARITY OF THE SENSE LEADS ARE REVERSED, THE CONTROL SECTION OF THE POWER SUPPLY WILL BE DAMAGED.

8. Connect power fail lead to TB1 terminal 4. This signal output is referenced to the main output (-) sense.

9. Connect On/Off lead to TB1 terminal 3. The power supply is turned on with open circuit or with TTL logic "1" and is turned off with TTL logic "0" (800mv max.) sinking 400μA referenced to negative sense.

10. Adjust V1 voltage adjust potentiometer to increase or decrease output voltage. Do not operate the power supply outside its nominal range.

11. Perform the following steps before operating the MM30 power supplies in parallel.

    A. Adjust the output voltage of each power supply within 0.1% of the other. These adjustments must be accomplished at 80 to 90% of full load, with the sense leads tied at the output terminals. The output voltage should be set high enough to allow for the estimated drop in the conductors, (due to load current) beyond the sense terminals.

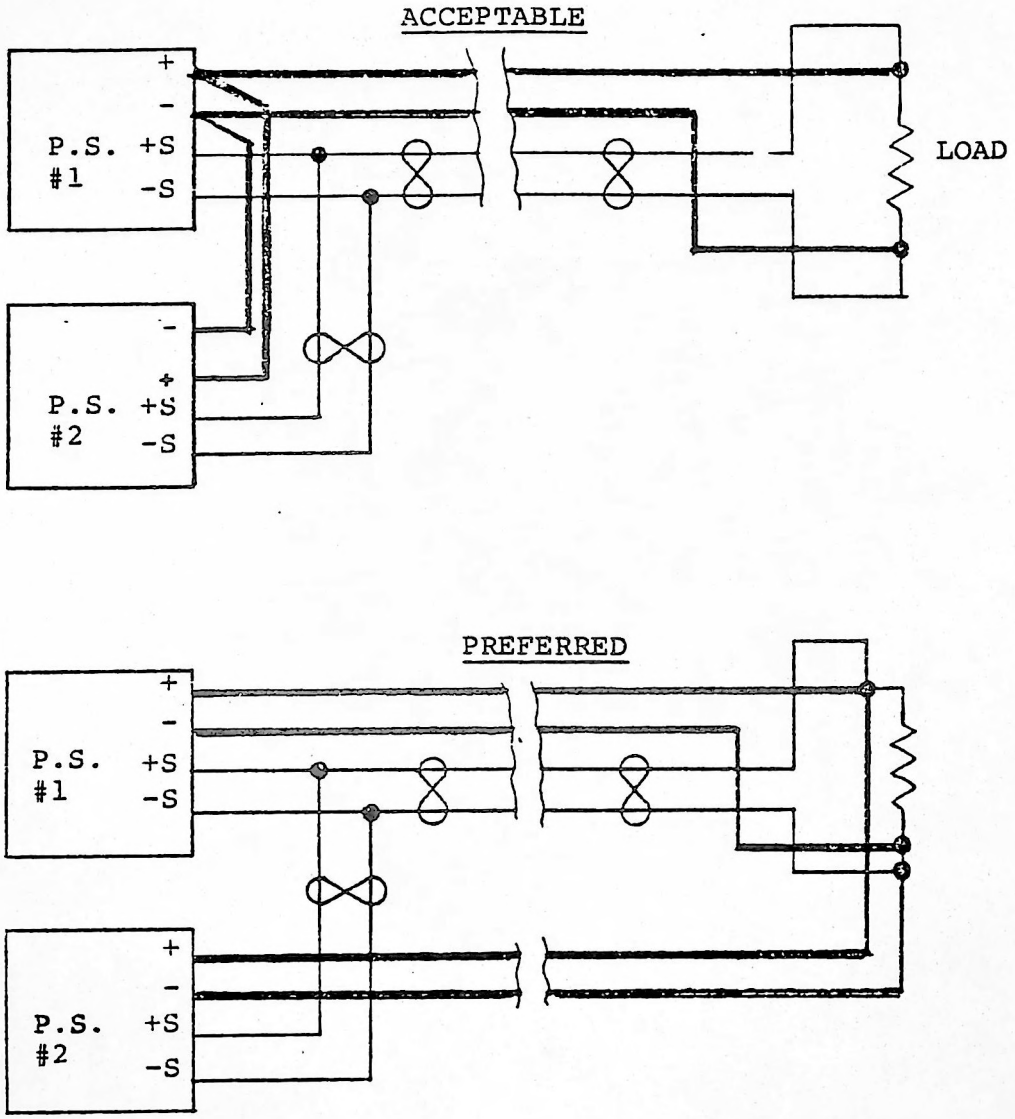
    B. Adjust the current limit on each power supply for 90 to 100% of the rating.

    C. The procedures outlined above will insure that the power supplies connected in parallel will share the load current reasonable well throughout its operating range and result in maximum reliability.

    D. The connection diagrams for power supplies operating in parallel are shown in Figure 6.

       NOTE: The adjustments described below are preset at final test and are for information only. Consult factory when requirements change. Changes in adjustments can cause loss of protective features of this power supply.

12. Adjust V1 voltage adjust potentiometer clockwise until the output reaches about 20% high. Turning pot R23 on the control module clockwise will make the OVP circuit trigger at a higher voltage. The minimum trigger point is around 20% high. This adjustment is most easily made when the main V1 output is loaded to less than 50% of rating.



NOTE: Load conductors should be same size and length, for proper load sharing.

Typical Parallel Diagram
Figure 6

13. With the line set at 115VAC, adjust the current limit pot R12 until the V1 output begin to fall with the output loaded for 100% of total power. This power level should be maintained for no longer than 30 seconds while making this adjustment.

CAUTION: OVERCURRENT PROTECTION FOR THE OUTPUT IS PROVIDED ON THE PRIMARY CURRENT SENSE. ALTHOUGH THE OUTPUT IS PROTECTED AGAINST OVERLOAD INCLUDING SHORT CIRCUIT ACROSS ITS OUTPUT TERMINALS, DAMAGE MAY RESULT IF THE OUTPUT IS OPERATED BEYOND ITS SPECIFIED RATING.

14. Connect scope probe to TB1-1 terminal 4. Adjust scope for 2V/Cm, 5MS/CM, external trigger. Adjust scope to trigger at AC line turn-off, adjust power fail pot R9, on the control module, until delay between line turn-off and power fail signal fall is greater than 16 Ms. (see specifications).

TROUBLESHOOTING

1. General

This section describes troubleshooting test analysis routine, and some procedures that are useful in servicing this power supply. Refer to the section on specifications for minimum performance standards.

2. Troubleshooting Procedures

No output voltage will probably be the most common failure mode of this power supply. Make certain the following items are checked before proceeding further:

A. Check to make sure the supply is properly hooked up.

B. Check the AC input voltage at the AC input terminals.

C. Remove the load from the supply to see if the supply will come up under a no-load condition. If it does, this would indicate there may be a short or overload condition in the load.

3. Troubleshooting Output Filter and Power Output Section

Shorts in the power output section can be determined with an ohmmeter.

Set the meter at the Rx 1 scale. Touch the plus lead to the plus output and the minus lead to the minus output.

Under normal conditions, there should be partial meter deflection and then a gradual increase in resistance as the meter will be charging the output filter capacitors.

If there is an internal short, the meter will read a very low resistance. When the meter leads are reversed, you will normally read a very low resistance because of the low forward resistance of the rectifiers. If a short is present, this could mean a shorted output rectifier or a shorted output filter capacitor. To check the rectifiers it will be necessary to remove the rectifier from the power supply assembly. The rectifiers can then be checked with an ohmmeter.

WARNING: ALWAYS MAKE SURE THE POWER SUPPLY HAS BEEN TURNED OFF FOR AT LEAST TWO MINUTES BEFORE WORKING INSIDE THE UNIT TO ALLOW THE VOLTAGE TO DISCHARGE FROM THE INPUT CAPACITORS.

4. Troubleshooting Input Section

Check the internal AC fuse F1 and if blown, replace with the same type and value. If the fuse blows again, it indicates a short in the AC input section.

If the supply continues to blow the AC input fuse when power is applied, check the diode bridge BR1 mounted on the filter board with an ohmmeter. Check the input filter capacitors for possible shorted conditions.

If the AC is present to the rectifiers and the high voltage is missing at the filter capacitors, check for an open thermistor. The proper voltage across the input capacitors C1 and C2 with nominal input voltage, should be about 150 volts DC across each capacitor. If there is no voltage across the input capacitor, check for an open connection. Examine the thermistors R1 and R4. The resistance of these thermistors should read about 2.5 ohms or 5 ohms when cool.

If normal voltage is present on input capacitors, check the DC fuses between the high voltage capacitors and the power transistors. If open, it will most likely indicate a power transistor failure or an internal short. Check the power transistors and clamp diodes for shorts. A shorted clamp diode maybe the cause of power transistor failure.

If a replacement power transistor is required, it is recommended that they are all replaced with a new tested set from LH Research. For optimum performance, the set is matched for storage time and switching speed.

When replacing power transistors, make certain the insulators are thoroughly greased with a thermal compound, and the mounting surfaces are free of burrs and foreign materials. Recheck the clamping diodes across emitter to collector of the power transistors to be sure none are shorted. Check the power transistor base voltage waveforms per step 5.

5. Check Power Transistor Base Voltage Waveforms

Set oscilloscope vertical sensitivity to .5V/Div. Set sweep to 5μs/Div. Remove the internal fuse F1 on input filter board. This will remove the 300 volts from the power switching transistors.

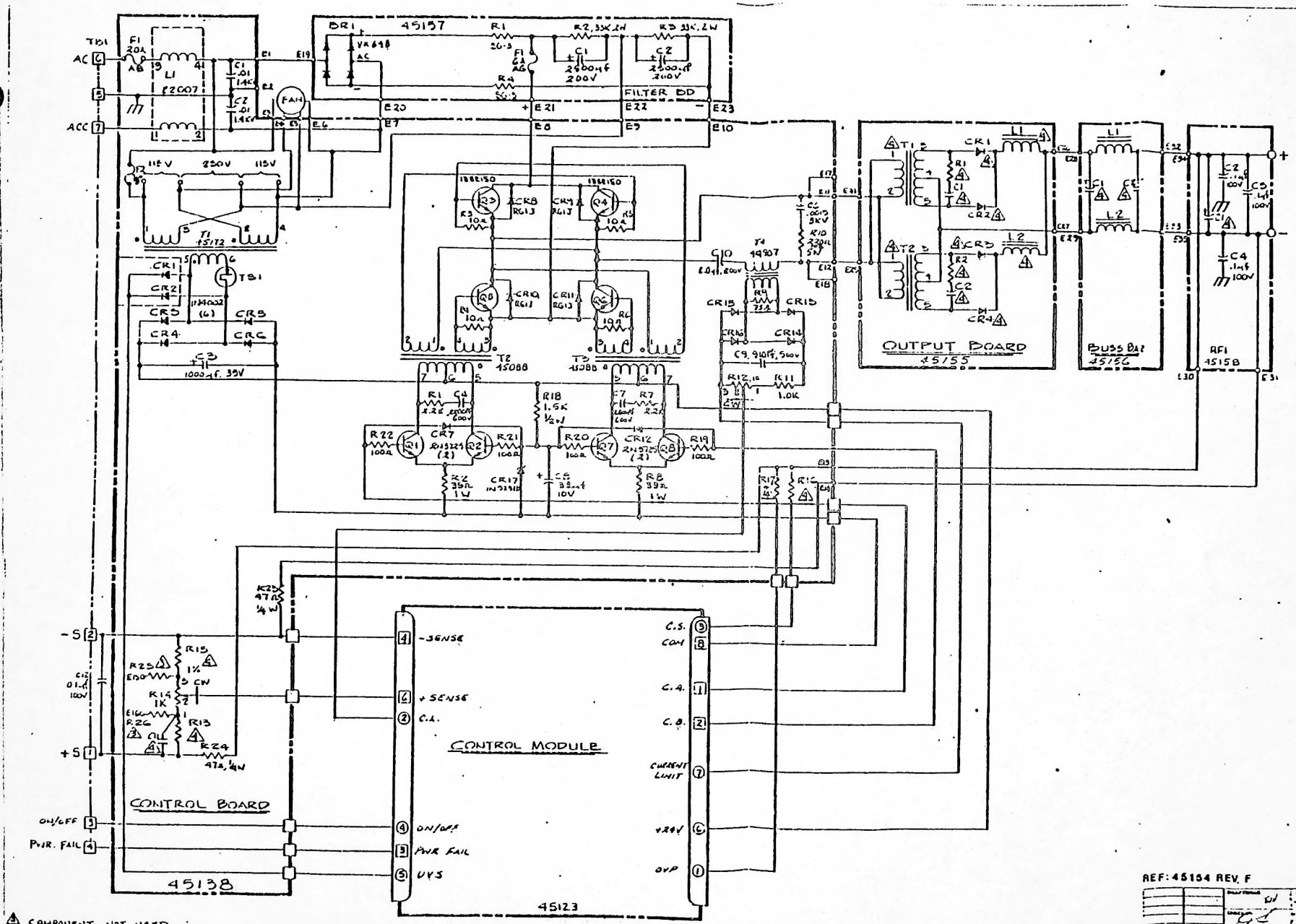
CAUTION: BEFORE MAKING ANY OSCILLOSCOPE MEASUREMENT, ISOLATE THE SCOPE CHASSIS FROM THE AC LINE WITH AN ISOLATION PLUG OR TRANSFORMER. MAKING SURE THAT THE SCOPE CHASSIS IS ISOLATED FROM EARTH GROUND. SCOPE CHASSIS MAY BE ELECTRICALLY HOT WHILE MAKING THE FOLLOWING MEASUREMENTS.

Observe the base-emitter voltage waveform on Q3, 4, 5 and 6, by hooking scope across transistor with scope ground on emitter side of transistor. See Figure 5 for proper waveform. Turn the AC power off and replace the DC fuse F1.

If no basic voltage waveforms are present, check the ±24 volts on the control board. With reference to the minus main output terminal, the 24 volts should be between 22 and 25 volts.

If the voltage is low or none, check fuse F2. If the fuse is open, check CR1, 2, 3, 4, 5 and 6 for possible short. If the diodes are good, replace F2 with same type and value.

If the fuse blows again or the base voltage waveforms are not present, the unit should be returned to the factory for repairs.



⚠ COMPONENT NOT USED
R. ALL DIODES ARE 1N4148
I. O SYMBOL INDICATES PI, □ SYMBOL INDICATES PC.

⚠ COMPONENTS VARY WITH OUTPUT VOLTAGE SEE APPROPRIATE ASSY. DASH NO. FOR COMPONENT VALUES.

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SCHEMATIC POWER SUPPLY

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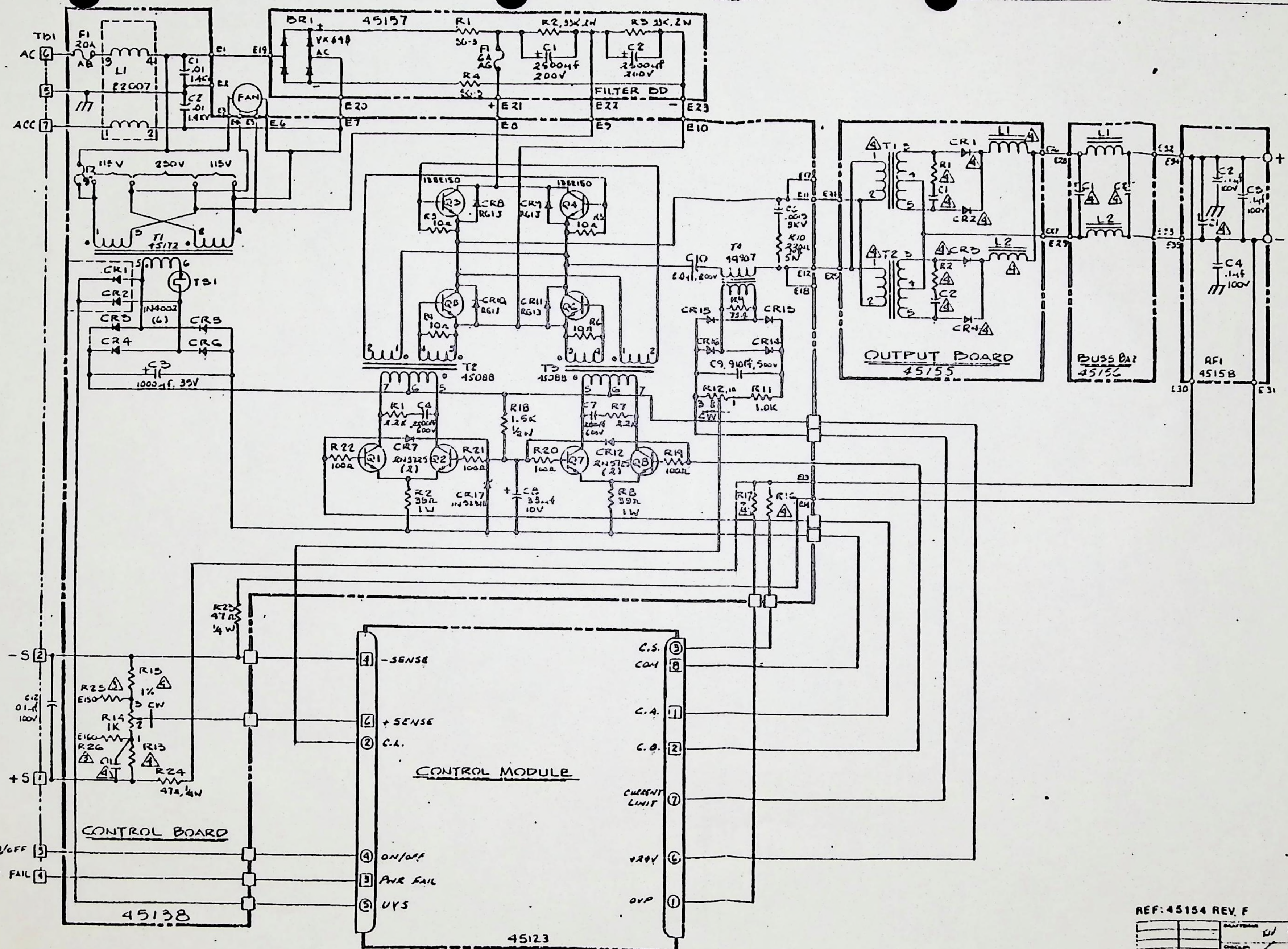

3. COMPONENT NOT USED
2. ALL DIODES ARE IN4148
1. ○ SYMBOL INDICATES P1, □ SYMBOL INDICATES P2.
NOTES: UNLESS OTHERWISE SPECIFIED

4. COMPONENTS VARY WITH OUTPUT VOLTAGE SEE APPROPRIATE ASSY. DASH NO. FOR CORRECT VALUES.

REF: 45154 REV. F

RESEARCH

SCHEMATIC, POWER SUPPLY

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Page 22 of 22